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ISDA 2010 Agriculture and Food
Innovation and Sustainable Development in Agriculture and Food
Montpellier – France
28 June – 1er July 2010
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Abstract: This article concerns the effectiveness of risk management strategies adopted by Chinese rural households, in western China where the economic and social context has changed greatly since the late 1990s. Drawing on an existing framework of risk management and vulnerability to poverty, we propose a new model based on qualitative data analysis and test it using quantitative data. We find that risk management strategies include self-insurance instruments, which involve households' assets and income diversification, and a risk-sharing strategy. Income diversification, precautionary financial saving, and informal social supports are major risk management strategies, which can be effective in reducing vulnerability. Compared with results of previous studies, we find risk management strategies have been revised; the revisions are caused by the rapid social and economic changes that have taken place since the late 1990s.

Keywords: rural households; risk; poverty; vulnerability

INTRODUCTION

As in most developing areas of the world, rural households face substantial risks, which can vary from flood to limited and uncertain rainfall. In western rural China, agricultural production must also contend with infertile soils and poor infrastructure. Since the late 1990s, environmental policies such as creation of nature reserves and the sloping land conversion policy (SLCP), have decreased the amount of arable land and increased rural households' subsistence risk. In addition, the recent success of market-oriented policy reforms has increased the degree of potential income instability due to fluctuation of crop prices, which has increased vulnerability of low-income families. In this context, Chinese rural households have developed a range of strategies to shield consumption from these risks, such as precautionary assets (Jalan and Ravallion 2001) and out-migration (Skeldon 2002). However, the effectiveness of these strategies has not been scrutinized.

Assessing the vulnerability of households has become a powerful tool for revealing the effectiveness of their risk management strategies. Numerous studies have focused on definition and measurement of vulnerability. Some of this research has been applied in developing countries, such as Indonesia and Nigeria. For example, Chaudhuri et al. (2002) define vulnerability as the probability that a household's consumption will fall below the poverty line in the near future, and measure vulnerability by predicting the mean and the variance of future consumption. Christiaensen and Subbarao (2005) give technical details of measurement methods. Empirical studies have so far focused on measurement of households' vulnerability rather than causes of the vulnerability. Usually the factors influencing vulnerability are some set of households' characteristics, but in most studies no conceptual model of vulnerability has been proposed.

Vulnerability of a household depends on its ability to smooth consumption in the face of various income shocks. For example, Chambers (1989) proposed a framework that emphasizes external risk and coping ability, but does not specify household risks and risk management strategies and is difficult to apply to concrete situations, especially in western China, which is in rapid social and economic transition. The challenge, therefore, is to construct a model of vulnerability to poverty that can be specific to local households' daily life.

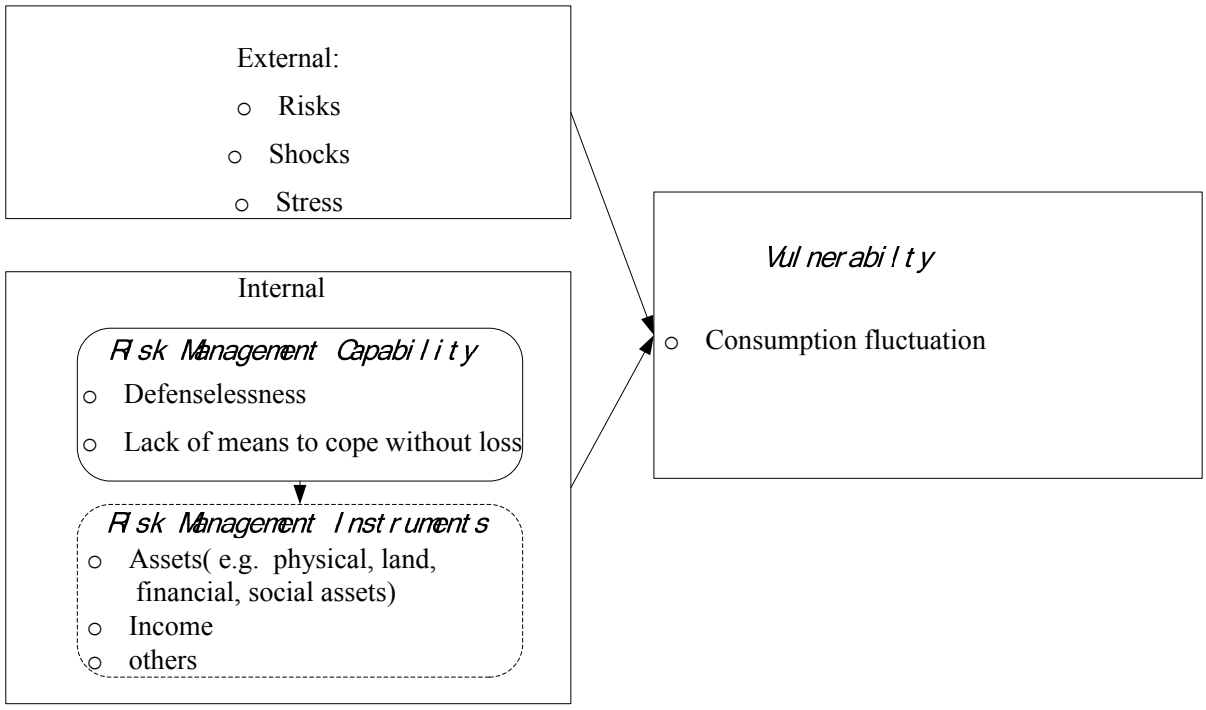
Our goal is to use the vulnerability framework of Chambers (1989) to construct a model of vulnerability that can be applied to risk management strategies used by western Chinese rural households, and to test the new model empirically. We begin by reviewing briefly this

vulnerability framework and discussing conditions under which it might apply to rural China. Next, we introduce our data source and analytical methods. The fourth part of the paper presents a new conceptual model which we evaluate statistically. We then discuss possible explanations for these results and assess the effectiveness of Chinese rural households' risk management strategies.

1. LITERATURE REVIEW

Empirical research has consistently found that households in poor developing areas have the ability to protect their consumption against a substantial fraction of income risks, but that full insurance is rarely achieved (Kazianga and Udry 2006). The degree of vulnerability depends on the characteristics of the risks and the households' ability to respond to risks (Dercon 2002). Chambers' (1989) framework for the relationships between risk and vulnerability is outlined in Figure 1.

Figure 1. Vulnerability Framework Proposed by Chambers



Source: *Prowse, M., 2004*

This framework has been widely utilized (Ellis 1998; Webb and Harinarayan 1999) and forms the basis for understanding the relationships between risk management and vulnerability. In this framework, vulnerability has two components: an external one that include risks, shocks, and stress to which a household is subject, and an internal one which is lack of defense ex ante, or lack of means to cope ex post (Prowse 2003).

Vulnerability begins with external risks, shocks, and stresses, the frequency, duration, and history of which affect vulnerability to poverty. Households can respond to, or manage risk in several ways (Prowse 2003). For Chambers (1989) and in subsequent literature, the internal element is especially important; it embodies risk management capability. If households are defenseless, risks can easily ruin them and drive them into poverty. This vulnerability may, for example, be due to a lack of precautionary assets. In Jalan and Ravallion's (1999) study of China, upper income deciles were much more successful than the poor because wealthy households had more precautionary assets, which allowed them to invest in risky behaviors to gain more profit than poor households. Lack of coping ability without damaging loss after shock is also an internal cause of vulnerability. Loss can take many forms--becoming or being physically weaker, economically impoverished, socially dependent, humiliated or psychologically harmed (Chambers 1989: 33). Sometimes, risk coping strategies taken by households are not feasible or sufficient to smooth consumption. Under such circumstances, they must take other more costly strategies that might undermine their future livelihoods. For example, Zimmerman and Carter (2003) find that poorer people are more likely to buffer consumption with production assets, which decreases their production in the subsequent production periods and increases their vulnerability when the next shock hits.

Rural households' risk management capability can be expressed in terms of risk management instruments (e.g., assets, income, etc.). Many studies have found that poor households' ability to cope with shock or risk is determined by their assets (Alwang et al. 2001). One way of smoothing consumption in the face of fluctuating incomes is to hold assets and to liquidate them when shocks occur. Asset items for consumption smoothing can take a wide variety of forms including jewelry, animals, crop inventory, or land (Balisacan and Fuwa 2007). Using the ICRISATVLS data, Rosenzweig and Wolpin (1993) found that in rural India, due to the lack of credit and leasing markets, some rural households purchase bullocks, important tools of traction, and sell them to acquire enough cash in the dry season to smooth households' consumption. Another of the most commonly used instruments to smooth consumption upon occurrence of a shock is temporary wage income employment. Kochar(1999) claims that the majority of Indian households reported the use of temporary wage income in attempting to smooth idiosyncratic crop shocks. Sometimes this includes an increase in the demand for child labor (Jacoby and Skoufias 1997). Takasaki et al (2001) show that households in the Amazonian tropical forest cope with both idiosyncratic and systemic shocks through labor supply, in the form of upland cropping and resource extraction.

Risk management strategies involve ex ante and ex post actions. Ex ante risk management may take the form of risk reduction (diversifying income), or investment in risk mitigation (precautionary savings). Ex post risk management may involve risk coping activities (sales of assets, using underemployed labor). Dercon (2002) pointed out that consumption smoothing entails costs when households face risks. Once the context has changed, it is possible that high cost strategies may be replaced by low cost ones. In India, for example, Rosenzweig and Wolpin (1993) consider bullocks as investments that provide high returns as a productive investment, but can also be used for consumption. However, other scholars have found no relationship between selling livestock and consumption smoothing, but that other assets functioned to mitigate shock and risk (Udry 1995; Fafchamps et al. 1998; Kazianga and Udry 2006). Udry (1995) finds that when households receive transitory shocks to their incomes, they respond by reducing their grain and cash savings, but livestock saving is unaffected. Kazianga and Udry (2006) find that households whose landholding make them more subject to future income fluctuations save more, but they report no evidence of households accumulating or selling livestock to shield their consumption from income shocks. It appears that risk management strategies are very diverse and can change quickly according to the context (Decon 2002).

The framework proposed by Chambers (1989), including internal and external factors, is useful in explaining risk management and vulnerability to poverty of rural households in developing countries. However, it is not appropriate for Chinese rural households. First, a typical feature of the Chinese rural economy is that male labor in a family chooses out-migration in order to diversify income (Skeldon 2002). As a result, risk management strategies of rural households may have changed since economic reform. In addition, external factors (e.g., positive supports) are not discussed in Chambers'(1989) framework. There is a growing body of literature that tests whether households within villages, regions, and even countries fully share risk. It appears that complete risk sharing is not taking place but that partial risk sharing may be occurring. For example, Morduch (1991) found that idiosyncratic risk accounted for 75 per cent to 96 per cent of the total variance of consumption in households in south India (citing Dercon 2002:143). Udry (1994) found that in the northern Philippines, consumption smoothing was attempted through gifts and informal zero-interest loans among relatively small networks of friends and relatives, rather than through livestock or grain stocks. In China, rural households pay more attention to risk-sharing as part of Chinese traditional culture. As many Chinese scholars point out, human relationships

dominate Chinese society (Yan 1996), which makes it easier for a family to get help from their friends and relatives when a disaster or risk takes place.

Thus, in spite of the importance of t Chambers'(1989) framework, we cannot be sure that it applies to rural China, especially in the poor western areas. In the following, we present a new conceptual model to describe the relationship between risk management strategies adopted by current western Chinese rural households and their vulnerability to poverty.

2. Methodology

2.1. The study area

The research was conducted in Zhouzhi County in the jurisdiction of Xi'an city, Shaanxi Province. The area was chosen because it is predominantly agricultural, and because strict environment policies have been implemented in recent years, which increased the subsistence risk and changed the livelihoods of local households, especially poor ones.

Although the county is in the domain of the capital Xi'an, Zhouzhi County is relatively poor compared with the other three rural counties and two suburban counties of Xi'an city. Zhouzhi County is the poorest, with income of only 38.07 million yuan in 2005, while its financial expenditure was 238.74 million yuan, a deficit of approximately 200 million yuan, most of which was covered by the city of Xi'an. The average income and consumption of rural households in Zhouzhi County are much lower than other rural households in Xi'an, and the national average.

The county has a total area of 2,949 km^2, of which 76.4 per cent is in the mountains constituting part of Qinling Ridge. The mountainous areas in the county have four administrative townships, which are especially poor and have inconvenient transport. Since the late 1990s, environmental protection in all of China has been strengthened, including the sloping land conversion policy(SLCP), which was implemented in 2002. After returning farmland to forests, labor is released from the land, and with China's rapid pace of urbanization, out-migration in order to earn some transient income has become the first choice for local rural households. According to data from Xi'an Statistics Yearbook (2006), there were only an average of 0.167 migrant workers in each family in 2002, but this number rose sharply to 0.785 per household in 2005.

Some of the sampled villages are located in the national nature reserve (Taibai Mountain Nature Reserve), where strict environmental protection policies have been adopted. Rural households face the following constraints: prohibition of logging, gathering, and digging herbs, and a ban on grazing in the mountains. These are the main income source of some

villagers who live outside the Nature Reserve, and play an important role in smoothing their risk shock.

The mountainous area of Zhouzhi County is severely affected by disasters such as drought and spring cold which reduce the output of fruit trees. In addition, with the stricter implementation of wildlife conservation policies in the late 1990s, especially in western areas, households' guns and other hunting tools have been expropriated. As a result, wild animals, especially crop-threatening animals such as wild boar and antelope, have increased rapidly, and farmers can do nothing about the resulting destruction of their crops. Autumn grain crops in particular are badly affected (Tai et al 2009).

2.2. Survey

As mentioned above, Zhouzhi County has four mountain townships that we chose as the site for our survey, which included two stages. The first stage was from February 2007 to April 2008, when we acquired qualitative data. The second stage was in April 2008, when we acquired quantitative data to test our conceptual model statistically.

2.2.1.First stage: Qualitative data

Following the framework (See Figure 1) proposed by Chambers (1989), the contents of the survey included: information about events resulting in economic hardship (e.g., family member's illness, crop loss); livelihoods in periods of economic hardship (such as assets, income, consumption, social links); amount and frequency of borrowing; attitudes to shocks and affects of shocks on their livelihoods. We also designed several semi-structured interviews in order to collect qualitative information about risks and rural households' risk management strategies over several years.

The qualitative survey included individual and focus group interviews. A two-stage stratified sampling technique was employed. The first phase involved choosing villages on the basis of the households' livelihoods (e.g., income from farming, nonfarming, and out-migration) and economic level to make the analysis representative. A total 20 of villages were sampled. In the second stage, typical sampling methods were applied to the households in each survey village. With the help of village officials, we chose the poorest families or families hit by disasters in recent years. We selected 3-4 households in each sampling village as individual interview respondents, and a total 74 households participated. In the group interviews, we asked the question, What affects your livelihoods and how does your family respond? Each survey village had three group surveys: one of village officials, one with a group of villagers, and one jointly with officials and villagers. The groups were sampled following a two-step process. First, we chose the four poorest villages as our village sample;

second, ten or so households in each of the chosen villages were randomly selected and assigned to three groups.

From February, 2007 to April, 2008, we interviewed rural households to assess the risks they are facing, the risk management strategies they adopt and their poverty status. All the interviewees were heads of households or their spouses. In the sample, males accounted for 66 per cent and females 34 per cent; the youngest interviewee was 30 years and the oldest was 65. Those aged 30-40 accounted for 13 per cent, ages 41-50 accounted for 34 percent, ages 51-60 accounted for 27 per cent, and above 61 accounted for 26 per cent. In terms of education level, illiterate or primary school educated were 43 per cent, secondary school educated were 49 per cent, and high school educated or above were 8 per cent; 88 per cent of the households had agriculture as their principal livelihood, 12 per cent were engaged in non-farm business, and 65 per cent had out-migration experiences. The average interview lasted about 50 minutes and we obtained 88 samples of oral texts which are crucial for the study. After the interviews, all the audio files were transformed into text files.

2.2.2. Second stage: Quantitative data

Quantitative data were collected during a survey in April 2008 with the aid of well-structured questionnaires, which drew on some that are commonly used to study rural households' livelihood (Oluwatayo 2004) and some used by the China Health and Nutrition Survey (CHNS). The questionnaires were restructured according to our qualitative results and revised after a pilot survey in the target area. They provided key household information on three subject areas. The first is demographic data, including household head, gender, marital status, and years of formal education, type of occupation, household size, social network, and total household income. The second is expenditure on commodities and such non-commodity items as hospital costs, etc. The third is other information including various income sources and the various risk situations associated with these sources. The villages in the quantitative survey are the same as those we had chosen in the first stage of the survey. Cluster sampling was applied to households in each survey village. All households in the villages were interviewed except for a few whose members were absent during the survey. A total of 1,078 questionnaires were administered out of which 1,074 are used in our analysis; the remaining four were rejected on the basis of obvious errors or lack of detailed information.

2.3. Methods of data analysis

2.3.1. Grounded theory

We use the grounded theory, a qualitative research method that constructs a conceptual model in accordance with data obtained from observation of subjects. In grounded theory, analysis

involves the assignment of concepts and themes to the data gathered. This process, called coding, consists of partitioning, conceptualizing, and integrating data to form a model (Rodon and Pastor 2007). A concept is an abstract representation of an event, object, or interaction that a researcher identifies as being significant in the data (Strauss and Corbin 1998:103, citing Rodon and Pastor 2007: 74). Our analysis begins with a microscopic (sentence-by-sentence) examination of each interview.

As mentioned earlier, we have attempted to make explicit the bases on which the categories were developed, and these categories may change through the several phases of coding. Certain categories clearly arose from the interview questions; for example, we specified such risk coping strategies as assets or incomes. Our qualitative analysis uses the method proposed by Miles and Huberman (1994), namely multi-staged coding. The first stage is open coding, in which we analyze the text sentence by sentence, and conceptualize this material. We developed 38 raw concepts and further classified them to give nine main concepts. The next phase is called axial coding; Strauss and Corbin (1998) suggest using a coding family that consists of causal conditions, the phenomenon, the contextual conditions, the intervening conditions, and the consequences of these. We used this method in this phase and consider risks, risk management capability, instruments, and actions of the sampled households. Following the analysis, the nine main concepts were subsumed by four core concepts. Finally, we examined the entire interview for themes and concepts paying particular attention to livelihood characteristics of local households, with a focus on their strategies for coping with risk in order to construct a new conceptual model with these four core concepts.

2.3.2. Feasible general least square

Our empirical method is an extension of that proposed by Chaudhuri (2002), and Christiaensen and Subbarao (2005) to estimate expected mean and variance of consumption, which reflect vulnerability. The main hypothesis is that the error term in a cross-sectional consumption regression captures the impact of idiosyncratic and community specific covariate shocks, and that this cross-sectional variance also reflects inter-temporal variance in consumption. To overcome the problem of heteroscedasticity, Christiaensen and Subbarao (2005) applied three-step feasible generalized least squares (FGLS) to estimate coefficients. Christiaensen and Subbarao (2005) give technical details on this widely used approach, which we used to estimate the variance of the idiosyncratic component of household consumption.

Chaudhuri (2002) and subsequent papers have not distinguished the factors affecting the mean and variance of future consumption; they just model these two with demographic variables heuristically. Based on our analysis of qualitative data, we explain this variance in

consumption in terms of our new conceptual model. Thus we extend the methodology of Chaudhuri (2002), Christiaensen and Subbarao (2005) by using a model for consumption variance.

3. A PROPOSED CONCEPTUAL MODEL

3.1. Conceptual model

Using open coding, we have conceptualized our qualitative data and summarized the factors influencing rural households' consumption strategies, and by axial coding we provide a higher level of conceptual abstraction. (See Table 1).

Table 1. Concepts of Coding

Raw concepts	Main concepts	Core concepts
a1 Cannot work due to illness a2 Difficult to earn enough money by work a3 Low crop yields a4 No non-farm income a5 Subsidies not available a6 No labor force	1.Income risks (a1- a6)	
a7 Overburden a8 High cost of daily living a9 Increased expenses a10 Price of goods rises	2.Consumption risks (a7- a10)	**A** Risks (1-3)
a11 House becomes shabby a12 Cattle get disease or die a13 Materials destroyed a14 Crops suffer disaster a15 The price of stock becomes cheaper	3.Assets risks (a11- a15)	
b1 Extend working hours b2 Increase labor intensity b3 Increase the labor force b4 Diversify activities b5 Payment in advance	4.Income diversification strategies (b1- b5)	
b6 Use savings b7 Sell assets b8 Exchange goods b9 Mortgage	5.Assets buffering strateg (b6- b9)	**B** Households bufferin instruments (4-5)
c1 Working opportunity c2 Fair sale c3 Rental availability c4 Loan availability	6. Market accessibility (c1- c4)	
c5. Borrow money c6. Cash transfer c7 Other help c8 Usury	7.Informal social support (c5- c8)	**C** Supports (6-8)
c9 Allowance c10. Subsidy	8. Formal social supports (c9- c10)	
d1 Lower standard of living		**D** Consumption

d2 Reduce unnecessary expense d3 Children drop out of school d4 Cancel plan to see a doctor	9. Consumption strategie (d1- d4)	fluctuation (9)

Source: *Survey data.*

Table 1 presents the concepts derived from analysis of qualitative data. Main concepts 1, 2, and 3 stand for the risks faced by rural households. Rural households are complex micro-systems and include cycles of production and consumption. Any stage in this cycle may be subject to risks. Households can convert their assets to investments to acquire income and then transform the income into welfare to obtain utility and the next livelihood process. In this cycle, Households can be affected by risks at any time. Therefore, we divide the risks into three categories: income risks, consumption risks and assets risks. Main concepts 4 and 5 stand for coping instruments adopted by rural households. When the household encounters risks to its income and assets, these resources will suffer temporary losses. For instance, the cost of children's education will reduce other family expenditures; if the main labor force in the household cannot work because of disease, other members in the household have to take over his/her farm work. Main concepts 6, 7, and 8 refer to the support available to the family when the risks are serious or long lasting. Main concept 9 refers to the consumption smoothing of fluctuation when shocks occur.

Table 1 shows the concepts and categories obtained after the primary analysis according to the grounded theory, and shows the complicated relationships between risks, assets, income, consumption, informal supports, market support and community organization supports. After further analysis of each main concept, four core categories are extracted in Table 1. A refers to factors such as the risks households face; B is buffering instruments such as assets and income; C is the available support rural households can receive when facing risk or shock; D is the consumption smoothing behavior of rural households. Income risks, consumption risks and asset risks are combined to form one concept termed risks, and this covers the adverse factors households encounter. Labor supply is classified as a buffering instrument. When rural households face risks, income and assets will be balanced tactically in different ways in order to seek stability. Adjustability of income and assets when a family faces risk is a buffering instrument in a family's response to risks. D is the consumption smoothing behavior of rural households, denoting vulnerability of households, then, A, B, and C are factors that influence D.

Based on the framework of Chambers (1989), we sort three factors A, B, C, into interior factors (B) and exterior factors (A and C). The former refers to the household's buffering capability towards risks, which is manifested, for example, in assets and income. The latter

include negative shocks and positive supports. In order to avoid excessive decline in future consumption and the large negative impact of unexpected risks on the family's life, the family has precautionary assets, income and exterior supports. The relations among A, B, C, and D are depicted in Figure 2.

Figure 2. A Proposed Conceptual Model

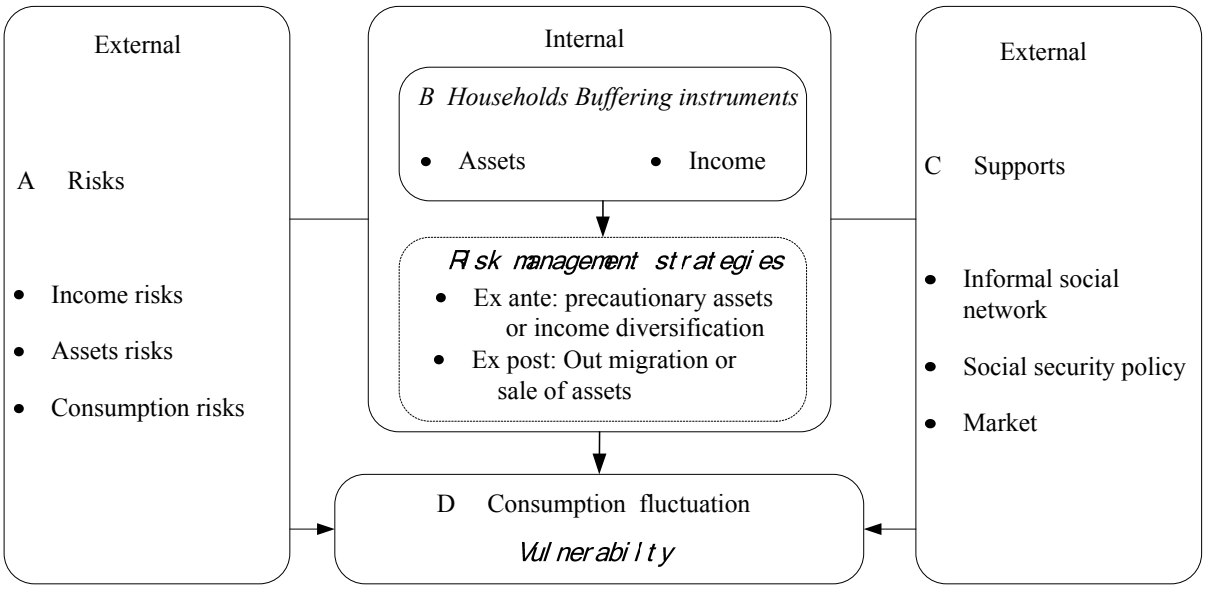


Figure 2 is a new conceptual model developed to take account of the economic transition in China. Our model has two major features. First, by explicitly modeling consumption smoothing, we include the specific risks households face and risk management instruments households may use, which can help to understand the causes of vulnerability. Second, in the new model, external factors are included both positive and negative: for example, formal and informal support, which are not included in Chambers' framework, are important to our analysis because human relationships dominate Chinese society in which sharing risks is especially important.

3.2. Test

We construct two statistical models; one for the expected mean consumption, and the other for the expected variance of consumption. The former model is based on the permanent income theory of Friedman(1956), in which the factors depend on physical assets, land, financial capital, human capital, and other demographic factors (Zhang and Wan 2006). The latter model is used to test the new conceptual model in Figure 2. The regression method is the three-step feasible generalized least squares (FGLS).

3.2.1.Variables

Consumption includes cash expenditure and imputed values for in-kind consumption from various sources (for example, food consumption, including grain, vegetables, meat, and

handicrafts, which are always self-supplied). The education of the householder indicates the household's human capital and whether or not there are savings indicates the household's financial capital. The household's physical capital includes the house, transport tools, grains, animals and durable goods. Since the household assets are usually diversified, we standardize the household's physical assets according to the method of Sharp (2003) to make them comparable. This method identifies physical assets as the house and other fixed assets. The value of the house varies according to type of house (such as concrete or wooden) and house size. In the survey, we chose 15 kinds of physical assets covering all types used by rural households and the measurement of the physical assets is the proportion of the number of assets that households reported out of these 15 kinds of physical assets. Finally, the house and other physical assets are weighted and summed to obtain a physical asset index between 0 and 1 (Sharp 2003). We also include the size of the household's land holding.

crop loss and illness risk are supposed to indicate the shock variable. There are two reasons for including these. First, from pilot interviews, we know that the local government has implemented a strict environmental protection policy, according to which wild animal hunting tools such as guns or spears have all been expropriated. Consequently, these animals have increased quickly and crops are frequently damaged. Second, illness is one of the most important reasons for Chinese rural households to fall into a poverty trap (Gao and Yao 2005). When a family member suffers from such a serious illness, that he/she is unable to work, the work of other members is affected by having to care for him/her; this will reduce household income. At the same time, high medical costs will reduce the daily consumption, including food, and as a result, the family may fall into poverty (Gao and Yao 2005). Responders reported their crop losses for 2007 in the questionnaire, and these losses are classified into four grades: under 500 yuan, 501-1,000 yuan, 1,001-1,500 yuan, and over 1,501 yuan. In the illness risk research of Gao and Yao (2005), illness shock variables were replaced by the question does the family member stay in hospital or not or is the annual medical expenditure more than 5,000 yuan. We use these but modify them in light of the local consumption level: illness shock will be said to occur if there are family members who have been in a hospital in 2007 or chronic disease consumption is more than 3,000 yuan in 2007.

We count the various income sources (household production, which includes farming, nonfarming, out-migration) and use three dummy variables to measure income diversification, such as does the family have only one source of income, does the family have two sources of income and does the family have three sources of income. Households' social capital can be measured by their social networks, which represent the amount of family support available

when they face income risks. Since the nature reserve policy has restricted farmers' livelihoods, we asked is the sampling village in the nature reserve? to assess whether this policy affects households' vulnerability to poverty.

3.2.2 .Results

FGLS Econometric results are shown in Table2.

Table 2 .FGLS Regression Results

Variables	**Consumption mean (Log)**	**Consumption variance**
Crop loss		0.007**
Illness risk		0.048***
Human capital (take Illiteracy as reference)		
Primary school	0.081***	- 0.064*
Junior high school	0.141**	- 0.097**
Senior high school	0.370***	0.002
Age of householder	- 0.012	
Household head age square	- 0.005***	
Household size	- 0.051**	
dependency ratio	- 0.115*	
Physical assets index	0.902***	- 0.021
Land size	- 0.009	- 0.006*
Financial capital	0.103**	- 0.022**
Migrant worker number	0.057*	0.030***
Income diversification (Take two sources of income as reference)		
One source of income	- 0.590***	0.219*
Three sources of income	0.108	- 0.312**
Policy factor	0.056**	0.032*
Social network		- 0.004***
Constant term	7.660***	0.321***
Adjusted R^2	0.495	0.240

Note : ** Significant at the 10% level.,** Significant at the 5% level;, *** Significant at the 1% level.*

We first compared households with two sources of income to those with one source of income. The latter had a much lower future mean consumption （–0.590，P<0.01），but the difference between having three sources of income and two is not significant (0.108, P=0.553). The physical assets index and financial assets have a significant positive influence on the mean future consumption, which suggests that the more assets rural households have, the higher the future consumption level, and the lower the vulnerability. Most of the households' demographic characteristics have significant effects on the mean future

consumption. The education at background of the household head has a strong positive influence on the mean future consumption. Compared with those who are illiterate, household heads with primary school and above have a much higher mean consumption. High human capital will increase permanent income, which will certainly affect the mean future consumption. Other demographic characteristics, such as the squared age of the household head and the dependency ratio, have significant negative impacts on the mean future consumption, because, as a result of the long-standing urban-rural division and poor social security in rural areas, the rural household head will be more conservative about consumption as his age or dependency ratio increase. The variable whether the village is in the nature reserve has a significant positive impact on the mean future consumption, probably because the nature reserve has existed for a long time. If householders earn their living as migrant workers, they have a higher net income than people from outside the region. This also seems to be confirmed by the fact that land size is not significant.

Second, both crop loss and illness risk have significant positive effects on the variance of future consumption, indicating that our sample of rural households cannot have full consumption smoothing. However, risk management strategies still work. For example, income diversification, financial assets and social networks all have significant negative effects on the variance of future consumption. For the two variables representing income diversification, households with one source of income have a higher consumption variance（0.219，P<0.10）than those with two sources of incomes, while, households with three sources of income have a significantly lower consumption variance than those with two sources of income (-0.312, P <0.05). Thus income diversification is an important way to cope with risk. The more diversification rural households have, the lower the fluctuation in future consumption, and the lower the vulnerability. The variables social network and whether the village is in the nature reserve also have significant effects (social network: -0.004, P <0.01, the policy factor: 0.032, P <0.1), Compared with households outside the nature reserve, households inside have a higher consumption variance; this is due to the environmental protection policies that limit availability of some transient income, which is important in dealing with income shocks. Land size has a significant but weak negative influence on the variance of future consumption, suggesting that although agricultural income is not the primary source of income, land still plays a role in livelihood security. Physical assets are not significant (–0.021，P=0.517), probably because the commodity and leasing markets are

poorly developed in mountain villages, where physical assets cannot play a role in buffering shock.

Last but not least, more meaningful conclusions can be drawn by comparing the influence on the mean and variance of future consumption of physical assets and income variables in Table 2. The physical assets index has a significant positive effect on mean future consumption, but not on its variance. Income diversification has a significant negative impact on consumption variance but only a limited affect on the mean consumption. Thus physical assets and income diversification have different effects on vulnerability to poverty.

4. Conclusions and Discussion

We find that the risk management strategies adopted by Chinese rural households include self-insurance (such as precautionary assets and income diversification) and risk-sharing (such as informal support, market and community organization). Income diversification significantly influences consumption variance, but has a very limited influence on the consumption mean. Financial assets significantly influence both the mean and the variance of expected consumption. However, we did not find that physical assets smooth consumption. We can therefore conclude that income diversification has become one of the major risk management instruments and can smooth consumption fluctuation when risk occurs; precautionary financial saving is another risk management instrument, but sale of physical assets is not a risk coping strategy.

That Chinese rural households employ precautionary saving as a risk management strategy agrees with previous research. For example, Jalan and Ravallion (2001), who studied behavioral responses to risks by rural households in China using panel data from 1985-90, found that Chinese rural households employ mainly precautionary savings against potential risk. Other scholars have also shown that accumulation of precautionary wealth is a self-insurance strategy. Households build up wealth so they can manage it as a buffer in order to smooth consumption after income shocks (Deaton 1991; Paxson 1993; Rosenzweig and Wolpin 1993). The assets that have commonly been studied as components of precautionary wealth portfolios are: livestock, inventories of grain, land, and cash. However, our results show that the sale of physical assets cannot become a coping strategy when risk hits. One possible explanation is that the assets market is less-developed in the part of rural China we studied. Compared to the rapid development of cities, the development of these markets in rural areas has been much slower. With no land market or second-hand commodity market, the development of marketization is unbalanced. Mortgages, for example, can never be used by the rural household to obtain temporary income for urgent use, and for the poor, there is

almost no way to obtain credit. In fact, the effectiveness of holding assets as a consumption smoothing strategy can be limited for various reasons: the returns on assets can fluctuate due to macroeconomic shocks. For example, in times of drought, the terms of trade between assets and food can collapse when everyone wants to sell assets (e.g. animals) and buy food (Dercon, 2005). Even worse, poor households will have no ability to recover due to the sale of productive assets for consumption smoothing purposes (Rosenzweig and Wolpin 1993).

Another possibility is that new instruments can serve to smooth consumption, replacing old smoothing instruments. We find income diversification has been both a risk management strategy ex ante and a risk coping strategy ex post. With such new consumption-smoothing mechanisms, it is not necessary for people to use precautionary assets against risks. Jalan and Ravallion (2001) also studied other behavioral responses to idiosyncratic risk but did not find temporary out-migration of labor to have the function of risk mitigation. At the time of their research, however, out-migration of labor could result in loss of land entitlement and hence food security. Further, farm labor markets were thin or non-existent. Thus, it was impossible for households to choose out-migration because they risked decreasing the household's consumption even with a labor surplus in the family. However, the social and economic context has changed greatly in rural China since the late 1990s. The market economy, especially the labor market, has developed greatly, and its influence extends to remote mountain areas. The livelihoods of rural households have changed; a typical feature is that important labor in a family chooses out-migration in order to diversify income (Skeldon 2002). Remittances by these migrants can help households overcome the credit shortage and market imperfection, and help to ensure the steady development of family production and maximize utility (Zhao 2003). On the one hand, this results from urbanization and relaxation of government regulations on labor movement. On the other hand, the steady decrease of the average land quantity and marginal agricultural productivity has forced farmers to choose out-migration in order to provide for their families. Many studies show that among the group of ex ante risk coping strategies, households may choose income diversification. The efficacy of this strategy has been studied in Pakistan by Kurosaki (2001), who finds that less diversified households are more vulnerable to risk. Migration is another way to diversify income. For example, Skeldon (2002) found that the likelihood of household participation in the labor market is higher with a negative shock. Kochar (1999) has suggested a labor supply model for families suffering from such effects. Specifically, when the shock does not damage male workers' health, the risk management strategy of rural households is to increase the male labor supply. However, if the male worker's health is damaged, then household consumption

smoothing will be affected. Our results show that income diversification is a risk management strategy and an efficient coping strategy. The relatively perfect local labor market has forced the rural households to use labor supply to smooth consumption.

We also find that informal support is a very important risk management strategy for Chinese rural households. China has a culture that emphasizes human relationships and face (Yan 1996), and rural households like to accumulate capital in their social network. Even very poor people spend much time and money on their social networks, which makes it easier for families to obtain assistance from friends and relatives when a disaster or risk takes place. Yan (1996) believes that lending among friends has strong vitality in rural China. It has the advantage of low cost, and the transaction is always between friends or relatives and has unlimited responsibility combined with the blood relationship. As a result, the moral hazard of the debtor is very small. The concept of human relationship in China emphasizes more about obligation; the closer or the more special the relationship, the more obligation one has to help, and this always plays a key role in the debtor-creditor relationship. This kind of obligation is a special component of Chinese culture, and is an endogenous constraint on communication in one's social network. From the Chinese cultural perspective, the role of risk-sharing is different from that usually conceived in the literature. In China, risk-sharing is common.
If our proposed model is correct, then our results raise an unsolved issue: what is the relationship between two risk management strategies, substitution and complementation? What kinds of households are likely to choose each one of them? These are issues that merit further research.

Acknowledgements This work is jointly supported by Programs for Changjiang Scholars and Innovative Research Team (IRT0855) in Universities of the Ministry of Education of China, the National Natural Science Foundation of China (70773094), the National Social Science Foundation of China (09JCY071), The Natural Capital Project (a partnership among TNC, WWF, and Stanford University), and Morrison Institute for Population and Resource Studies at Stanford University. We are grateful to many people interviewed for their patience and assistance.

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